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 DECELERATIONS WITH LATE COMPONENTS
 IN THE SECOND STAGE OF LABOR AND
 UMBILICAL CORD ARTERY PH

A thesis submitted to the
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 of the University of Cincinnati

in partial fulfillment of the requirements
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 in the College of Nursing and Health

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ABSTRACT

THE RELATIONSHIP BETWEEN DECELERATIONS WITH LATE COMPONENTS
IN THE SECOND STAGE OF LABOR AND
UMBILICAL CORD ARTERY PH

This study explored the relationship between decelerations with late components in the second stage of labor and umbilical cord artery pH at birth. Physiologic theories state that late decelerations reflect fetal stress and potentially compromised fetal oxygenation. A retrospective study of 30 births was conducted. The subjects selected were the first 30 fetal monitoring tracings meeting research criteria of over 300 reviewed at a mid-western military medical center. For each subject, the researcher recorded all decelerations with late components. The mean length of the late component, mean length of the deceleration, and the percent of contractions involved with these decelerations was calculated for each subject. The subjects were then sorted into two groups based on the pH of the umbilical cord artery at birth, pH <7.2 and pH ≥7.2. Five of the 30 were in the low pH group. The two groups were demographically similar. The data were analyzed using correlation and t-tests. Weak negative correlations were found between the mean length of the late component, mean length of the deceleration, percent of contractions involved, and the pH. When the two groups were compared, the lower pH group had significantly longer decelerations and a higher percentage of contractions involved with decelerations. Also, no subject in the low pH group had a mean late component length of less than 60 seconds. The investigator concluded that the findings identify a need for further research to verify the relationships found.

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Chapter 1

Introduction to the Study

Introduction

During the second stage of labor, fetuses commonly experience early and variable decelerations. These decelerations can develop late components in which the return to baseline occurs after the contraction ends. Occasional late decelerations are accepted as a beginning sign of fetal stress. Whereas, persistent late decelerations, with most or all contractions indicate fetal distress. The obstetrical provider must determine when the decelerations become suggestive of fetal distress indicating the need for an urgent assisted delivery.

Purpose

The purpose of this study was to describe the relationship between decelerations with late components in the second stage of labor and the subsequent effect on the arterial pH of cord blood at birth.

Significance

A reassuring fetal heart rate (FHR) pattern usually results in the birth of a hemodynamically stable newborn. Most infants in poor condition at birth due to prolonged hypoxia had some abnormality (i.e. decreased variability or late deceleration) on their FHR tracing during labor (Freeman, Garite, & Nageotte, 1991). However, all such abnormal FHR tracings do not result in hypoxic newborns

(Freeman et al., 1991). The FHR tracing commonly shows decelerations in the second stage of labor. No clear description exists for the number or duration of decelerations with late components required to indicate fetal distress. Since fetal distress leads to hypoxia which, in turn, causes acidosis, the most objective noninvasive measurement of the newborn's status at birth was the pH of an umbilical cord artery blood sample. The findings from this study may add to the body of scientific knowledge, may provide a better base for nursing practice, and may provide information to help the obstetrical health care team make decisions about the method of delivery of these fetuses.

Review of the Literature

Previous studies. Although decelerations in the FHR are common in the second stage of labor, little has been done to determine when these decelerations indicate fetal compromise. In the literature, the studies on FHR in the second stage of labor focus more on the effect of the overall FHR pattern on umbilical cord pH (Gilstrap, Hauth, & Toussaint, 1984; Gilstrap, Hauth, Hankins, & Beck, 1987; Piquard, Hsuing, Mettauer, Schaefer, Haberey, & Dellenbach, 1988; Steer, Eigbe, Lissauer, & Beard, 1989). All researchers reported some increased association between second stage FHR tracing abnormalities and acidotic newborns as compared with FHR tracings with no abnormalities. Pello,

Rosevear, Dawes, Moulden, and Redman (1991) distinguished late decelerations in the second stage from other patterns and were surprised to discover that their presence poorly correlated with acidemia at birth ($r=-0.11$).

None of these studies attempted to examine the relationship between the number and/or duration of decelerations and the cord pH. The literature does provide some useful information on interpreting second stage labor tracings. However, each study had its limitations. For example, Gilstrap et al. (1984) used either arterial or venous cord pH samples. The cord pH values cannot be compared accurately when the source can be either arterial or venous--normal arterial pH values are ≥ 7.2 , while venous pH values are ≥ 7.25 (Gilstrap et al., 1984; Martin & McColgin, 1990). The study operationally defined acidosis as arterial or venous pH values < 7.2 and thus eliminated those acidotic newborns with venous pH samples between 7.2 and 7.25.

The data provided by Steer et al. (1989) classified the fetal strips as either normal or abnormal. The presence of a baseline FHR other than 120-160, decelerations with late components, and/or minimal variability made a tracing abnormal in the second stage. None of the individual abnormal factors correlated as well with acidosis as the combined abnormal group did. However, the r values (0.26)

for decelerations differed little from the grouped r value (0.28).

For the last hour of labor, Pello et al. (1991) used computer FHR analysis to obtain the mean lag time or the length of delay from the peak of the contraction to the trough of the late deceleration. The data were correlated with umbilical artery pH values. The focus on the lag time from the contraction peak to the deceleration trough did not consider the effect of the length of time the FHR took to recover from the deceleration and return to baseline.

In summary, these studies were considered only for the information provided in the situations described. Other valuable information, such as how frequent the late decelerations occurred, has not been addressed in the literature.

Theoretical rationale. The search for the relationship between decelerations with late components and umbilical cord pH was based on the physiologic theory that the FHR pattern reflects the adequacy of fetal oxygenation. The physiologic theory encompasses descriptions of the processes of fetal oxygenation, FHR monitoring, the proposed effect of oxygenation on the FHR, and the effect of fetal oxygenation on fetal umbilical cord pH values.

The fetus receives oxygen from the mother via the placenta. The maternal uterine arteries supply blood to the spiral arteries. The spiral arteries travel through the

uterine myometrium to the intervillous space within the placenta. Oxygen, carbon dioxide, nutrients, and waste products are exchanged between the fetal capillary and the intervillous space. The umbilical vein carries the oxygen and nutrients to the fetus. Carbon dioxide and wastes travel to the placenta via the two umbilical arteries. Any factor that decreases uteroplacental or placental-fetal blood flow can impair this exchange and cause hypoxia in the fetus (Freeman et al., 1991). Examples of decreased blood flow include placental abruption, excessive uterine activity, maternal hypertension, and umbilical cord compression. These events also can increase the carbon dioxide tension in the infant's blood that may lead to acidemia or acidosis.

The FHR monitor calculates the FHR from the intervals between successive R waves of the fetal QRS complexes. The monitor either directly evaluates the R waves via an internal fetal scalp electrode or adequately approximates it with a doppler ultrasound system (Freeman et al., 1991). The FHR monitor also can simultaneously display the maternal uterine contraction pattern. The monitor determines contractions either directly through an internal pressure transducer or estimated via an external abdominal tocodynamometer or toco. The pressure transducer evaluates the pressure changes inside the uterus. The toco senses the

changes in the pressure exerted on the surface of the abdomen from the uterine muscles.

The FHR is determined by the fetal atrial pacemaker and modulated by both parasympathetic and sympathetic factors (Freeman et al., 1991). Parasympathetic and sympathetic impulses originate in the fetal brainstem and travel to the heart. The opposing stimuli cause the FHR to fluctuate, creating a normal variability of rate from one beat to the next. In addition to variability, periodic changes in the FHR, such as decelerations and accelerations, may also occur.

The classification of decelerations as early, variable, and late refers to when they begin in relation to contractions. A late deceleration is characteristically defined as a gradual decline in FHR that usually begins after the peak of the contraction with a delayed return to the baseline rate after the end of the contraction (Freeman et al, 1991). These decelerations result from decreased uteroplacental oxygen transfer to the fetus. Freeman et al. (1991) described two mechanisms for their occurrence. In intermittent hypoxia without acidemia, the chemoreceptors stimulate an adrenergic response causing hypertension that triggers the baroreceptors to signal a parasympathetic drop in the FHR. When the hypoxia occurs with acidemia, myocardial depression results and causes the FHR to fall. The deceleration with the late component refers to any type

of onset (early, variable, or late) with a gradual or delayed return to baseline after the contraction ends.

The deceleration with a late component can suggest fetal acidemia. Profound hypoxia at the tissue level causes anaerobic metabolism that leads to acidosis (Freeman et al., 1991). Acidemia results from profound hypoxia and/or increased carbon dioxide tension in the blood. Carbon dioxide in equilibrium with the water in the blood forms carbonic acid and lowers the pH of the blood (Martin et al., 1990). The blood sampled from the umbilical cord after delivery can come from either an umbilical artery or the vein. The pH from the vein reflects only the status of the blood exchange in the placenta and may not accurately define the status of the fetus at birth. The blood samples obtained from the arteries reveal the status of both placental perfusion and fetal perfusion (Martin et al., 1990). For this study, the umbilical pH values evaluated were obtained from an umbilical artery.

Statement of the Problem

Research questions. The general research question was: what is the relationship between second stage labor decelerations with late components and the umbilical cord artery pH of the neonate? More specifically, the research intended to answer the following questions: does the mean length of the late component, the mean length of the

deceleration, or the mean ratio of involved contractions affect the acidity of the umbilical cord artery at birth?

Conceptual and Operational Definitions

Second stage of labor. The second stage of labor, began when the woman's cervix fully dilated to ten centimeters and ended with the birth of the neonate. The exact moment the cervix completely dilated was difficult to determine. Frequently, a period of decreased uterine activity occurred between the time of complete dilation to the appearance of an urge to push. Often, a vaginal exam was not done until the urge to push presented; consequently, the precise start of the second stage was missed. For the purposes of this study, the second stage of labor began with the first push by the mother after the nurse or physician documented on the FHR tracing that the cervix dilated completely.

Fetal oxygenation. Fetal oxygenation referred to the amount of oxygen the fetus received through the placenta that was then bound to fetal hemoglobin.

Decelerations with late components. Decelerations with late components occurred when the FHR began to slow down (decelerate) at any point during a contraction (early, late, or variable) and gradually returned to the baseline rate after the contraction ended. The part of the deceleration that occurred after the end of the contraction was defined as the late component for this study. All FHR decelerations

(drops in FHR below the baseline rate established by that fetus) that occurred during each subject's second stage of labor were assessed by the investigator. Each deceleration was compared to the contraction during which it occurred. If the FHR returned to pre-deceleration rate after the end of the contraction the deceleration was considered to have a late component. The end of the contractions was determined by the return to the pre-contraction level of the tocodynamometer printout on the tracing. To maintain consistency, the exact end of each contraction was measured at the first of two consecutive points that dropped to identical (precontraction) levels.

The FHR tracings were printed at a speed of three centimeters per second; thus each five millimeters (mm) equaled 10 seconds. The late components were calculated by measuring from the point where the contraction ended to the point where the FHR returned to baseline (for a period lasting more than 15 seconds). Similarly, the interval between the beginning of the deceleration and the point where it returned to baseline measured the total time of the deceleration. Both these measures were independently averaged for each subject. Finally, the investigator found the ratio of contractions that experienced these decelerations by taking the total number of decelerations and dividing by the total number of contractions during this stage of labor.

Umbilical cord artery pH. The umbilical cord artery pH was the dependent variable for this study. At each delivery in the study setting, standard protocol required the physician or midwife (birth attendant) to obtain two umbilical cord blood specimens, one each from an artery and the vein. Martin and McColgin (1990) asserted that umbilical artery blood better represented the status of the fetus because this blood returns from the fetus to the placenta. The umbilical cord artery pH represents the log of the hydrogen ions in a sample of umbilical arterial blood. The vein better represents the placental status and this value was not used for this study. The nurses documented both values in the mother's and neonate's records. Normal values for the umbilical artery pH are greater than or equal to 7.20 with severe acidosis occurring with values below 7.10 (Martin et al., 1990). PH values were calculated in the medical center's laboratory and rounded off to the nearest one thousandth decimal place.

Influencing variables. The following data were collected from the subject's delivery record: maternal age, race, parity, weeks gestation, amniotic fluid color, maternal oxygen and oxytocin use, type of continuous electronic fetal monitoring (internal or external), method of delivery, sex of the infant, Apgar score, presence of nuchal cords, and pregnancy complications. These data were compiled to describe the characteristics of the population.

Chapter 2

Methodology

Introduction

The investigator designed a study utilizing existing maternal and neonatal records to collect the data needed to describe the relationship between decelerations with late components and the umbilical cord artery pH value. In this chapter the study design, subject selection, and data gathering procedures will be presented.

Design

Type of study. A retrospective study using a descriptive correlational method was used to examine the relationship among the variables. The study consisted of a review of FHR tracings, maternal inpatient records, and the delivery room register.

Setting. Data collection occurred at a military medical center located in the midwest. The center has 900-1000 births per year.

Subjects. Subjects were selected from women, age 18-38, who delivered between January 1, 1991 and June 30, 1992. Women with a history of medical problems prior to the pregnancy were excluded from the study. The investigator reviewed the FHR tracings of term or postterm (>37 weeks gestation by dates) singleton deliveries. The tracings that contained legible, continuous fetal monitoring in the second stage of labor were considered eligible for the study.

Those tracings that contained decelerations with late components were selected. Therefore, the women from whom the tracings came made up the accessible population.

A convenience sample of 30 women comprised the study sample. The first 30 women meeting eligibility criteria were selected for the sample. The first step of the selection process was a random selection of FHR tracings from women who delivered during the specified time. The FHR tracings were stored according to the last two digits of the sponsor's (active duty family member) social security number. The investigator scanned over 300 tracings removing each record in the order that it was stored until 40 legible records with decelerations with late components were found. Forty tracings were selected to account for possible subject exclusion based on delivery record data. The subject's register number and delivery date were noted. Each subject was assigned an identification number. Additional information about each subject's pregnancy was obtained from the delivery register. Six tracings were dropped because umbilical cord blood gases were not available in the subject's record. Another subject was eliminated because of her age (16). During the analysis of each subject's FHR tracing, three additional subjects were dropped from the study because of monitoring problems (long periods of unmonitored time). Therefore, the final sample size was 30 FHR tracings.

Instruments

Data were collected strictly from the pre-existing maternal records. The subjects were selected from the fetal monitor tracings that met the inclusion criteria. The investigator analyzed the contractions and decelerations of each tracing. All tracings had been made using either internal or external transducers and Hewlett Packard monitors. All data were recorded on the investigator developed data collection worksheet (see Appendix A).

Procedures

Data Gathering. After obtaining approval from the institutional review committee, the investigator reviewed each FHR tracing and analyzed each deceleration that met the criteria. The investigator first determined the baseline FHR and the baseline resting tone of the uterus. Next, the investigator compared the end of the deceleration to its corresponding contraction. Transparent graph paper was used to accurately line up the end of the uterine contraction with the FHR. The investigator then used a metric transparent ruler to measure the millimeters from the end of the contraction to the end of the deceleration. Each millimeter measured two seconds of FHR. The length of the deceleration after the end of the contraction was recorded. The total length of each deceleration with a late component was measured using the same technique. The total number of contractions and total number of these decelerations was

recorded. When a deceleration encompassed more than one contraction, the number of contractions involved was noted and recorded.

The investigator obtained the umbilical cord pH values and descriptive data from the delivery records of the discharged mothers. The investigator did not have access to the umbilical cord artery pH values during the measuring of the FHR tracings.

The investigator studied three FHR tracings with a perinatologist from the medical center and a graduate student with perinatal expertise from the University of Cincinnati to improve reliability. All concurred with the investigator on the measurements for the tracings of the subjects.

The collected data were entered into a computer. The data were then examined using Q and A Assistant software and statistically analyzed using SPSS PC+ Student software. The Q and A Assistant software separated the data for closer analysis. The statistical programs run were correlation analysis and independent measures t-tests. The alpha level was set a priori at 0.05.

Chapter 3

Presentation of Findings

Introduction

The data were analyzed for all 30 subjects and then the subjects were divided into two groups. Data for the two groups were analyzed separately and then compared to each other. In this chapter, the statistical analysis of the groups' demographics and the characteristics of the study variables will be presented.

Characteristics of the Subjects

Demographics. The study subjects were 30 intrapartum women. After all data were gathered, the subjects were divided into two groups for analysis based on the pH of the umbilical cord artery sample, <7.2 and ≥ 7.2 . The age, weeks gestation, race, and parity of the subjects are summarized in Table 1. No subjects had any medical complications noted during this pregnancy. Three subjects were successful vaginal births after caesarean section. There were three subjects with elevated temperatures during labor (>99.9 F). One fetus was tachycardiac (>180); the mother of this fetus was one of the women with an elevated temperature. Only five subjects had epidural anesthesia during their intrapartum experience; all others had either intravenous analgesia, local anesthesia, and/or no medications. One subject had poor weight gain noted in her delivery records.

Table 1

Age, Race, and Parity Characteristics Of Subjects

Characteristic	Group		
	pH <7.2 (n=5)	pH ≥7.2 (n=25)	All Subjects (n=30)
Mean Age (Range)	26 (20-30)	26 (18-38)	26 (18-38)
Racial Composition			
Caucasian	80% (4)	88% (22)	86% (26)
African American	0% (0)	8% (2)	7% (2)
Asian	20% (1)	4% (1)	7% (2)
Parity			
Primipara	40% (2)	52% (13)	50% (15)
1 Births	60% (3)	32% (8)	37% (11)
2-3 Births	0% (0)	16% (4)	13% (4)

() = exact number or range

% = percent of group or sample

Second stage labor attributes. In Table 2, the length of the second stage of labor, the presence of meconium, the use of oxygen and/or oxytocin, and the methods of fetal monitoring are presented. The length of the second stage of labor ranged from the shortest at 10 minutes to the longest at 177 minutes. The mean length of labor for all patients was 53.3 minutes. The five subjects with a pH <7.2 had a mean labor length of 36.8 minutes. The remaining subjects had a mean length of 56.6 minutes. The variability was also assessed for each FHR tracing. Forty percent of both groups had moderate (>6 beats per minute) short term variability. The remaining 60% in the pH <7.2 group had minimal (3-5 beats per minute) variability. In the pH ≥7.2 group, 28% had minimal variability, 28% had a mix of minimal and moderate variability, and 4% had a mix of minimal and absent

(0-2 beats per minute) variability. Severe variable decelerations were noted on three subjects' fetal heart tracings, one of whom was in the pH <7.2 group.

Table 2

Second Stage of Labor Attributes

Attribute	Group		
	pH <7.2 (n=5)	pH ≥7.2 (n=25)	All Subjects (n=30)
Length ≤ 2 hours	100% (5)	88% (23)	90% (27)
Length > 2 hours	0% (0)	12% (3)	10% (3)
Meconium stained amniotic fluid	40% (2)	20% (5)	23% (7)
Oxytocin used	20% (1)	20% (5)	20% (6)
Oxygen used	60% (3)	64% (16)	63% (19)
Fetal monitor method			
Ultrasound	0% (0)	8% (2)	7% (2)
Scalp electrode	100% (5)	92% (23)	93% (28)
Contraction monitor			
External	80% (4)	84% (21)	83% (25)
Intrauterine pressure catheter	20% (1)	16% (4)	17% (5)

Delivery characteristics. The deliveries for the subjects are summarized in Table 3. The deliveries were complicated by a nuchal cord in 36% (n=11) of all the subjects. In the lower pH group, 80% (n=4) experienced a nuchal cord. Of the seven subjects (28%) with a nuchal cord in the pH ≥ 7.2 group, one had a triple nuchal cord and one had a shoulder cord. No other subjects had more than a single nuchal cord. Shoulder dystocia complicated only one delivery and was in the pH ≥ 7.2 group.

Table 3

Method of Delivery

Method	Group		
	pH <7.2 (n=5)	pH ≥ 7.2 (n=5)	All Subjects (n=5)
Spontaneous	80% (4)	76% (19)	77% (23)
Suction	0% (0)	16% (4)	13% (4)
Forceps	20% (1)	8% (2)	10% (3)

The one minute Apgar scores ranged from five to nine. The two infants with a one minute score of five were divided between the groups. The infants' five minute Apgar scores are summarized in Table 4. The lowest five minute score was five and occurred in the pH ≤ 7.2 group. Two infants in the ≥ 7.2 group had five minute scores of seven. All other five minute scores were eight or nine.

Table 4

Infant Apgar Score at Five Minutes

Apgar Score	Group		
	pH <7.2 (n=5)	pH ≥7.2 (n=5)	All Subjects (n=5)
Apgar < 7			
Females	20% (1)	4% (1)	7% (2)
Males	0% (0)	4% (1)	3% (1)
Apgar ≥ 7			
Females	60% (3)	52% (13)	53% (16)
Males	20% (1)	40% (10)	37% (11)

Characteristics of Study Sample's Variables

The umbilical cord artery pH mean was 7.25 with a standard deviation of 0.078 and a range of 0.38 (6.99 - 7.37). The decelerations are described in Tables 5, 6, and 7. The mean, standard deviation, and range for both the length of the deceleration that occurred after the contraction (late component) and the length of the total deceleration are presented. Also listed is the percent of contractions involved with these decelerations.

Table 5

Summary of Decelerations with Late Components for pH <7.2
(n=5)

Description	Mean	Standard Deviation	Range
Length of late component (minutes)	4.48	4.93	1.05 - 13.00
Length of total deceleration (minutes)	5.31	4.68	2.28 - 13.42
Contractions with decelerations	63%	38%	10 - 100%

Table 6

Summary of Decelerations with Late Components for pH >7.2
(n=25)

Description	Mean	Standard Deviation	Range
Length of late component (minutes)	1.83	1.38	0.30 - 5.40
Length of total deceleration (minutes)	2.73	1.78	0.92 - 7.70
Contractions with decelerations	40%	23%	7 - 83%

Table 7

Summary of Decelerations with Late Components for All Subjects (n=30)

Description	Mean	Standard Deviation	Range
Length of late component (minutes)	2.28	2.43	0.30 - 13.00
Length of total deceleration	3.16	2.57	0.92 - 13.42
Contractions with decelerations	44%	26%	7 - 100%

Data Analysis

Correlation of the decelerations with late components with the umbilical artery pH. For each subject, the mean length of the FHR decelerations with a late component, the mean length of the late component, and the percent of contractions involved with these decelerations was calculated. A Pearson correlation of umbilical cord artery pH value with each of the mean values and the percent was done. All three had a weak negative correlation as listed in Table 8.

Table 8

Correlation Analysis of Umbilical Artery pH with the Length of the Late Component, Length of the Deceleration, and the Percent

Variable	Correlation Coefficient**	One-Tail Significance
Length of late component	-0.1765	0.175
Length of total deceleration	-0.1177	0.268
Percent of uterine contractions involved with these decelerations	-0.2869	0.062

**For $n=30$, a correlation coefficient of .306 is required for $p=0.05$.

Test of whether the mean late component length is significantly longer in the lower pH group. Using an independent measures t statistic, the mean length of the late component in the $pH < 7.2$ group was significantly longer [$t(30)=2.4$, $p=0.012$, 1-tailed]. However, statistical analysis indicated that homogeneity of variance could not be assumed at an alpha level of 0.05. Therefore, the length of the late component can not be adequately compared.

Test of whether the mean total deceleration length is significantly longer in the lower pH group. Using an independent measures t statistic, the mean length of the total deceleration in the $pH < 7.2$ group was significantly longer [$t(30)=2.18$, $p=0.019$, 1-tailed]. Thus, the mean deceleration is statistically longer in the lower pH group.

Test of whether the mean percent of contractions involved with these decelerations is significantly greater in the lower pH group. Using an independent measures t statistic, the mean percent of contractions involved with these decelerations in the pH <7.2 group was significantly greater [$t(30)=1.8$, $p=0.0425$, 1-tailed]. Therefore, the mean percent of contractions involved with these decelerations is statistically greater in the lower pH group.

Chapter 4

Discussion of Findings

Introduction

The purpose of this study was to describe the relationship between decelerations with late components during the second stage of labor and the umbilical cord artery pH at birth. In this chapter, the investigator will discuss the findings of both demographic data and data related to the research questions. In addition, the scope and limitations of this study will be presented.

Demographics

The two groups did not differ significantly in their demographic configuration. The mean age was identical for the total study sample and each smaller group. Due to the small sample size, the ethnicity may not be truly reflective of the total population. About half of the women were first experiencing their first childbirth. No women in the pH <7.2 group had more than one previous birth. This finding may be related to the small size of that group. Overall, the sample had demographic data comparable for the larger population of the military base.

Labor Attributes

Length of the second stage. The mean length of the second stage of labor for the lower pH group was considerably shorter (36.6 minutes) than the group with the normal pH (56.6 minutes). The only second stage of labor

that lasted longer than two hours occurred in the $\text{pH} \geq 7.2$ group. Therefore, longer pushing stages did not increase the likelihood of acidosis and may have provided more time for the fetus to recover from stress in utero.

Maternal medication. The frequency of oxytocin usage for either augmentation or induction was identical for both groups. Oxygen was administered in similar proportions in both groups. Consequently, neither medication was under or over represented for the two groups. Therefore, the difference in pH values between the two groups may not be attributed to demographic differences.

FHR Variability. Each group had moderate FHR variability in 40% ($n=2$, $n=10$) of the subjects. Variability was therefore not a factor for these subjects.

Meconium stained fluid. Meconium stained fluid occurred twice as frequently in the lower pH group (40% versus 20%). Thus, the presence of meconium stained fluid with decelerations with late components could be interpreted as a possible sign of a decreasing fetal pH value.

Delivery characteristics. The methods of delivery were similar for both groups. For subjects in the $\text{pH} < 7.2$ group, nuchal cords occurred 80% of the time. The normal pH group had nuchal cords in only 28% of the births. However, all the noted tight nuchal cords, more than single nuchal cords, and shoulder cords occurred in the $\text{pH} \geq 7.2$ group.

Therefore, the exact role nuchal cords played in the acidemia at birth remains unclear.

Characteristics of Study Sample's Variables

An overwhelming majority ($n=25$ or 83%) of the subjects had a normal pH. This concurs with the study by Pello et al. (1991) that found that the presence of late decelerations poorly predicted acidemia at birth.

Correlation. The results of the correlation analysis revealed weak relationships between the umbilical artery pH and the length of the late component, length of the total deceleration, and the percent of contractions involved with these decelerations. The two weaker relationships, the length of the late component ($r=-0.18$) and the length of the deceleration ($r=-0.12$) were similar to the weak relationship that Pello et al. (1991) found when relating the lag time of late decelerations in the last hour of labor to the umbilical artery pH ($r=-0.11$). The strongest relationship found was that between the percent of contractions involved with these decelerations and the pH ($r=-0.29$). This is similar to the findings of Steer et al. (1989) who found a correlation ($r=0.26$) when comparing FHR tracings which had second stage labor late decelerations with normal FHR tracings and their relationships to acidemia at birth. The weak correlations found in this study may be due to a smaller sample size.

Student t tests. The mean length of the late components could not be compared because the homogeneity of variance could not be assumed. However, reviewing the data for clinical significance there may be some significant difference between the two groups. The shortest mean length in the acidotic group was 63 seconds, while the normal pH group had a mean as short as 18 seconds. The maximum length of the late component for the $\text{pH} \geq 7.2$ group was 324 seconds (5 minutes and 24 seconds) and for the $\text{pH} < 7.2$ group was 780 seconds (13 minutes). The analysis did reveal a statistically significant longer mean length of the total deceleration in the lower pH group. Also noted was a significantly higher percentage of contractions with these decelerations in the lower pH group as compared to the normal pH group.

Overall Summary of Findings

There were weak correlations between the mean length of the late component, the mean length of the deceleration, and the mean ratio of the involved contractions and the acidity of the umbilical cord artery at birth. Because of the weak correlation, a relationship can not be assumed between the aspects of these decelerations and the pH. However, further exploration of the differences and similarities between the acidotic and the normal pH groups further suggested that a relationship existed--longer late components, longer

decelerations, and more frequent decelerations contributed to the development of acidosis in the neonates.

Since the majority (83%, n=25) of these fetuses who experienced late components during labor had a pH ≥ 7.2 , and some fetuses in both groups had long late components (>5 minutes), long decelerations (>8 minutes), and high percentage of contractions involved (>80%), no absolute relationship can be described. Therefore, a degree of variability may not result in as dramatic shifts or alterations due to the law of initial value that states that the degree of variability will be affected by the beginning or initial baseline parameter (Benjamin, 1963 & Benjamin, 1967). Therefore, resulting fetal acidosis may be related to the fetal baseline physiologic status prior to the second stage of labor. Fetal monitoring in the second stage of labor may be beneficial, but exceptions to FHR interpretation exist. Therefore, it is necessary to look beyond the FHR as the sole determinant of the acidity of the infant at birth. Perhaps these decelerations do not predict acidosis at all and simply reflect normal physiologic reactions to labor by the fetus.

Scope and Limitations

Factors that may be limitations to the findings are inherent to the design and analysis procedures used for data collection. The small number of subjects in the pH <7.2 group may have affected the accuracy of the findings. Since

the subjects were not completely randomly selected, the results are only generalizable to populations with similar demographics in medical facilities with similar policies, procedures, and equipment.

Because the data came from pre-existing records, the investigator had no control over the variability caused by differences in the techniques of monitoring, cord blood sampling, and arterial blood gas (ABG) analyzing. Thus individual differences in documentation and procedures by the nurses, physicians, and technicians involved could have affected the accuracy of the collected data. The investigator also depended on proper functioning and control of the electronic fetal monitoring and ABG analyzing equipment. The results were additionally limited and possibly skewed by the exclusion of illegible strips from the data. Continuity of fetal monitoring was interrupted during transfer from the labor room to the delivery room. Hence, there was a period of one to five minutes where FHR tracings were not available for analysis. Therefore, not having the pattern of FHR during that time period may be considered a limitation. Women that had data gaps for greater than five minutes were excluded from the investigation. Longer delays from the end of FHR monitoring to the delivery of the infant during a cesarean section caused these patients to be excluded from the study and also limited the scope of the results.

Further limitations occurred as a result of the inability to control the physiologic processes of labor and the interventions of the staff. The unique way each woman pushed (position, bearing down effort, breath holding) might have impacted the decelerations and/or the pH values. The cord pH values could also have been affected decreased uteroplacental blood supply that may not have caused these decelerations. Interventions by the health care staff, such as changing maternal position, increasing intravenous fluids, and administering oxygen, could have affected the deceleration patterns and/or the pH values. Another limiting factor was the lack of attention to the events of the first stage of labor on the cord pH. Using correlation limits the generalizability to the range of data represented in this study.

Chapter 5

Summary of the Study

Summary

Decelerations in FHR are a common occurrence during the second stage of labor. Regardless of the point of initiation, the decelerations frequently develop late components. Since late components in the monitoring tracing are thought to represent decreased uteroplacental oxygen transfer, the question was asked how do these decelerations relate to the acidity of the umbilical cord artery pH at birth? Related literature reported an association between abnormal FHR tracings, including late decelerations, and umbilical artery pH. However, all studies also noted that not all abnormal FHR tracings result in acidotic infants. Only one study by Pello et al. (1991) attempted to quantify late decelerations while correlating it to the umbilical cord pH. That study found a weak correlation between umbilical cord pH and the lag time of late decelerations (the time from the peak of the uterine contraction to the trough of the deceleration) in the last hour of labor.

Thus the investigator set out to determine if the mean length of the late component, the mean length of the total deceleration and/or the percent of contractions involved with these decelerations affected the acidity of the umbilical cord artery pH at birth. A retrospective study

using a descriptive correlational method was used to examine the relationship between the variables.

The study took place at a military medical center located in the midwestern United States. The subjects were selected based on the legibility of their FHR tracings and the presence of decelerations with late components during the second stage of labor. Subjects were further limited by age (18-38), and the absence of pre-existing medical conditions. The investigator randomly reviewed over 300 FHR tracings, accepting the first 30 eligible subjects. Each FHR tracing was then analyzed for the length of each late component, length of each deceleration, and the number of contractions involved with these decelerations. Additionally, the total number of the contractions and demographic data were collected. The investigator then calculated the mean length of the late components, the mean length of the decelerations, and the percent of contractions involved with these decelerations for each subject. To further evaluate the relationships, the subjects were divided into two groups, $\text{pH} < 7.2$ and $\text{pH} \geq 7.2$. These two groups were then compared independent measures t-tests. The alpha level was set a priori at $p \leq .05$.

The two pH groups did not differ significantly in their demographics. The mean age was 26, approximately half were primiparas ($n=2$, $n=13$), and none had any pregnancy complications noted. The FHR variability was similar in the

two groups, both had 40% (n=2, n=10) with moderate variability, and thus was probably not a contributing factor to the pH differences. The mean length of labor was actually shorter in the lower pH group. Oxygen and oxytocin use were nearly identical in both groups and therefore determined not to be a factor in the comparison of these groups. Nuchal cords occurred with much greater frequency in the lower pH group (80%, n=4 out of 5, versus 28%, n=5 out of 25). Therefore, the presence of a nuchal cord most likely contributed to the lower pH value.

Correlation analysis of the length of the late component and the length of the decelerations with the pH value revealed weak relationships ($r = -0.18$ and -0.12 respectively). A slightly stronger relationship was found between the percent of contractions involved and the pH value ($r = 0.29$). Hence, it could not be assumed that any of these variables directly affected the pH value.

A comparison of the two pH groups did reveal statistically significant differences ($p \leq .05$). The mean length of the total deceleration was significantly longer in the lower pH group ($p = .019$). Also, the percent of contractions involved was significantly greater in the pH, 7.2 group ($p = .04$). Therefore it was determined that these factors most likely had an affect on increasing the acidity.

Interpreting the findings from the study, would lead one to conclude that fetuses with longer decelerations and more frequent decelerations are more likely to have a lower pH than those with quicker recoveries and fewer decelerations. However, since a majority (83%, n=25) of these fetuses with decelerations with late components had a pH ≥ 7.2 , an absolute relationship could not be defined. Many subjects in the pH ≥ 7.2 group had equally long and frequent decelerations as those in the acidotic group. Therefore, another possible conclusion is that the deceleration with the late component is not a predictor of acidity at birth, but rather a normal physiologic response to labor by the fetus.

One limiting factor of the investigation was the small sample size. Since the subjects were not completely randomly selected, the results are only generalizable to the current population. Because these data came from pre-existing records, the investigator had no control over the variability caused by differences in the techniques of monitoring, cord blood sampling, ABG analyzing, interventions, and consistency of charting. Another limiting factor was the lack of attention to the events of the first stage of labor on the cord pH. Periods of missing FHR data during the transfer of infants to the delivery room was another limiting factor.

Recommendations for Further Study

A larger scale study is recommended to determine if the weak relationships found in this investigation exists in other studies. These studies should include investigation of whether less frequent and shorter late components are benign physiologic occurrences as compared to the longer, more frequent late components. Future studies should use a prospective design to improve consistency in FHR monitoring, ABG analyzing, and documentation. A prospective design would also enable evaluation of how interventions affect the these decelerations and the pH value. Additionally, an investigation that includes consideration of the first stage of labor would be beneficial. It would be better if the next study was conducted in labor/birthing rooms to avoid the time off the FHR monitor during transfer. Newer monitors with computerized analysis and recording might allow for more accurate comparisons of the FHR tracings.

Since this study found no statistical difference in the variability between the acidotic and normal pH groups, further investigation is needed into whether a relationship between variability and pH exists. Also, in this study, 80% of those in the acidotic group had deceleration that lasted through the birth of the infant as compared to only 48% in the normal pH group. This could be interpreted that the fetuses were distressed, hence the deceleration and inability to recover, or that in utero recovery of the FHR

enables better fetal oxygenation/acid-base balance. Closer scrutinization of this relationship between the lack recovery of the late component before birth and acidemia is needed. An investigation into the possibility that late components are normal physiologic responses to labor and not predictors of poor fetal status is also suggested.

Appendix A

Subject # _____ Register # _____ Page __ of __

TOTAL TIMELENGTH OF LATE COMPONENT

1.	_____	_____
2.	_____	_____
3.	_____	_____
4.	_____	_____
5.	_____	_____
6.	_____	_____
7.	_____	_____
8.	_____	_____
9.	_____	_____
10.	_____	_____
11.	_____	_____
12.	_____	_____
13.	_____	_____
14.	_____	_____
15.	_____	_____
16.	_____	_____
17.	_____	_____
18.	_____	_____
19.	_____	_____
20.	_____	_____
21.	_____	_____
22.	_____	_____
23.	_____	_____
24.	_____	_____
25.	_____	_____

TOTAL: _____

TOTAL # OF DECELS: _____

AVERAGE: _____

TOTAL # OF CONTRACTIONS: _____

DECELS/# CONTRACTIONS X 100: _____

Subject # _____ Register # _____ Page ____ of ____
 AGE: _____
 RACE: _____
 # PREVIOUS BIRTHS: _____
 LENGTH OF 2ND STAGE: _____
 MECONIUM STAINED FLUID: YES or NO
 OXYTOCIN USED**: YES or NO
 MATERNAL OXYGEN USE**: NONE NASAL CANNULA FACE MASK
 TYPE OF MONITORING**:
 FETUS: EXTERNAL SCALP ELECTRODE BOTH
 CONTRACTIONS: EXTERNAL IUPC BOTH
 METHOD OF DELIVERY: VAGINAL SUCTION FORCEPS C/S
 INFANT SEX: FEMALE or MALE
 APGAR: 1 MIN _____
 5 MIN _____
 UMBILICAL CORD PH: ARTERY _____
 VEIN _____

COMMENTS: _____

**Refers to use or administration in second stage of labor only.

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